001402

AC NO: 20-57A

DATE: 12 Jan 71

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AUTOMATIC LANDING SYSTEMS (ALS)

1. PURPOSE. This circular sets forth an acceptable means of compliance but not the only means for the installation approval of automatic landing systems in transport category aircraft which may be used initially in Category II operations. Approval of these aircraft for use under such conditions will permit the accumulation of data for systems which may be approved for Category IIIa in the future.

2. REFERENCES. Federal Aviation Regulations 21.21, 25.1301, 25.1309, 25.1581, and 121.579; ICAO Annex 10.

* 3. CANCELLATION. AC No. 20-57, dated 29 January 1968, is cancelled. *

4. DISCUSSION.

   a. Applicants are obtaining approval of aircraft equipped with systems for use during Category II operations. Automatic landing capability is included in, or planned for, some of these aircraft. Manufacturers and operators have indicated a desire to utilize that capability under visual landing conditions, when such aircraft are found satisfactory for making automatic landings during normal operations.

   b. The accumulation of service experience in an operational environment and the development of confidence in such systems are considered essential parts of the evolutionary process in aircraft design associated with further reduction in weather minimums for future operations.

   c. Aircraft which demonstrate in service use capability of meeting touchdown limits, as defined in paragraph 5b, may be expected to comply with touchdown dispersion criteria for operation under Category IIIa conditions, according to best information available to FAA at this time.

Initiated by: FS-130

5. AUTOMATIC LANDING SYSTEM CRITERIA.

a. General. ALS evaluation should be based on the use of ILS approach facilities which meet the following performance on a two-sigma basis (95.5% probability of occurrence in a normal distribution):

Localizer (to touchdown) - Course Alignment Accuracy ± 10'
- Bends ± 5ua
- Airborne Receiver
Centering error - ± 5ua [1] *

Other characteristics as recommended in ICAO Annex 10 dated April 1968 for Category II.

Glide Slope - Airborne Receiver Centering Error - ± 10ua [1]
Other characteristics as recommended in ICAO Annex 10 dated April 1968 for Category II.

Monitor - Automatic monitoring system as recommended in ICAO Annex 10 dated April 1968 for Category II. *

Computer analysis of system performance should be based on these ground facility characteristics. Analysis of results of in-flight demonstration should include compensation for beam deviations (such as subtraction of beam deviations beyond 10 feet and treatment of the remainder on a probability basis with other variables) when these are found to be in excess of the permitted tolerances.

b. Aircraft Touchdown Limits. The automatic landing system should be demonstrated to achieve the accuracy limits listed below, considering the full range of c.g. limits and landing weights.

(1) Environmental conditions to be considered in the determination of dispersion limits are: Headwinds up to 25 knots; tailwinds up to 10 knots; crosswinds up to 15 knots; moderate turbulence, wind shear of 8 knots per 100 feet from 200 feet to touchdown.

(2) Confirmation of compliance with such limits may be demonstrated by a combination of:

(a) An analysis considering reasonable combinations of environmental conditions noted in (1) above, using wind model described in Appendix 1.

(b) Flight demonstrations as appropriate to verify results of the analysis.

*
[1] Or the equivalent when a receiver with a high level output is used. *

* (3) Distribution of touchdowns about a nominal point on a two-sigma basis should be established with reference to the desired airplane/system characteristics, as follows:

(a) Longitudinal dispersion about the nominal point of the main landing gear touchdown should not exceed 1500 feet total, but need not be symmetrical about the nominal point.

(b) Lateral dispersion of the aircraft centerline at the main landing gear should not exceed 27 feet either side of the centerline of the runway.

(4) A suitable computer analysis should show that under realistic environmental conditions including the wind model described in Appendix 1, the touchdown performance will be such that landing outside of the prescribed dispersion area will be improbable.

(a) Longitudinal touchdowns between a point at least 200 feet beyond the threshold and that point down the runway at which the pilot is in a position to see at least 4 bars (on 100' centers) of the 3000 foot touchdown zone lights.

(b) Lateral touchdowns with the outboard landing gear no closer than five feet from the lateral limits of a 150 foot runway. *

c. Automatic landing system malfunction should not:

(1) Cause significant displacement of the aircraft from its approach path, including altitude loss.

(2) Upon system disconnection, involve any out of trim condition not easily controlled by the pilot.

(3) Cause any action of the flight control system that is not readily apparent to the pilot, either by control movement or advisory display.

d. Means should be provided to inform the pilot continuously of the mode of operation of the automatic landing system. Indication of system malfunction should be conspicuous and unmistakable. * Positive indication should be provided that the flare has (or alternatively has not) been initiated at the minimum normal flare engage heights. *

6. AIRPLANE FLIGHT MANUAL. Information pertinent to the operation of the automatic landing system and aircraft limitations should be included in the airplane flight manual.

R. S. Sliff

Acting Director, Flight Standards Service

* APPENDIX 1. WIND MODEL FOR APPROACH SIMULATIONS

The cumulative probability of mean windspeed is as shown on page 2 of this appendix.

Turbulence is made up of three components, longitudinal, vertical and lateral (see page 3 of this appendix).

The turbulence rms level is directly proportional to the mean windspeed.

The effect of turbulence is a function of the aerodynamic characteristics and dimensions of the airplane.

The power spectrum of turbulence is defined by:

$$\phi(\omega) = \sigma^2 \left(\frac{2L}{\pi V}\right) \left(\frac{1}{1 + \left(\frac{L\omega}{V}\right)^2}\right)$$

ω = frequency rad/sec

σ = rms turbulence intensity

L = scale length feet

V = airplane velocity feet per second

Longitudinal Turbulence

L = 600 feet
σ_u = .15 mean headwind or tailwind (knots)

Vertical Turbulence

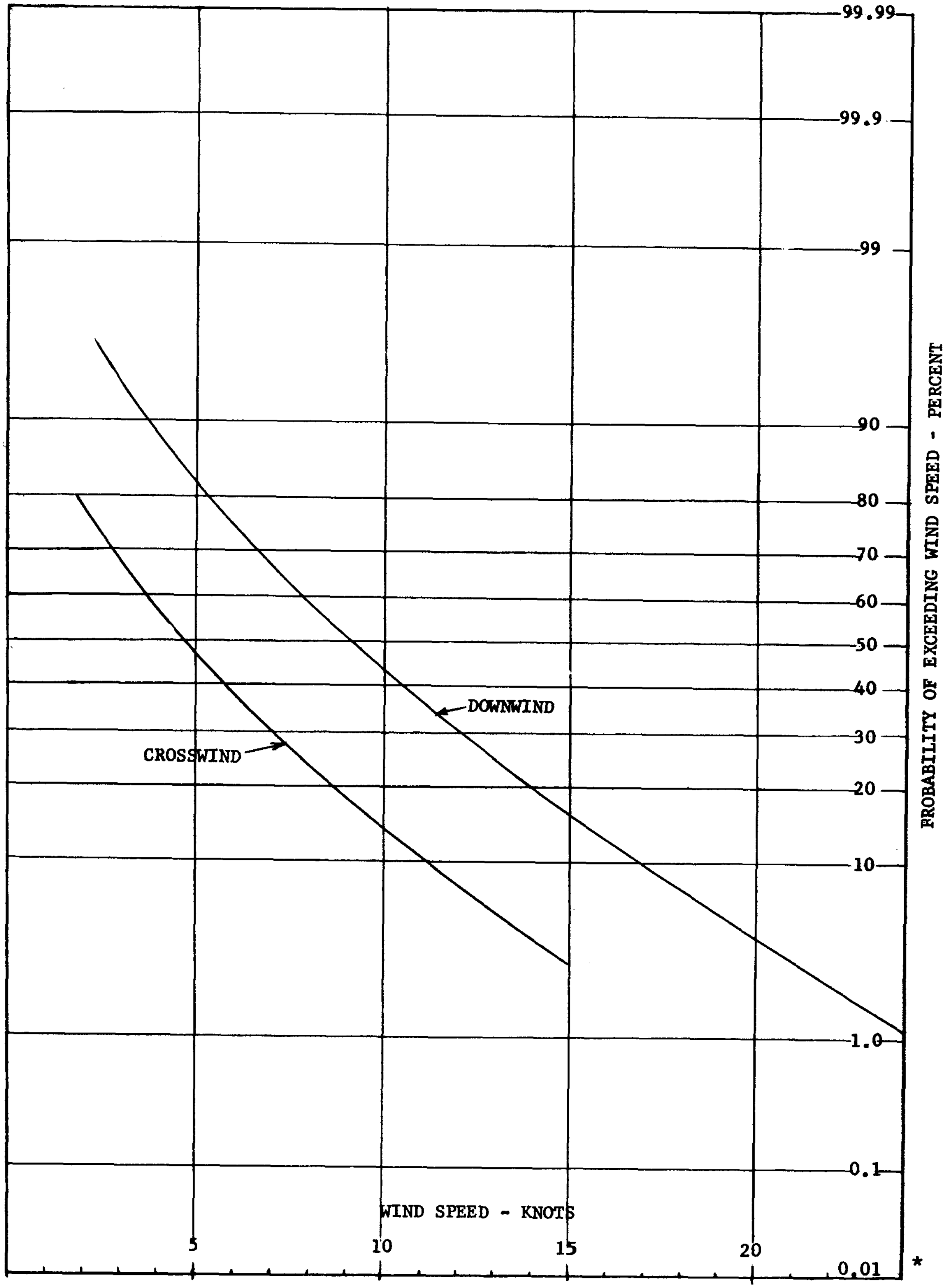
L = 30 feet
σ_w = 1.5 knots

The effect of vertical turbulence is small and a constant level is satisfactory.

Lateral Turbulence

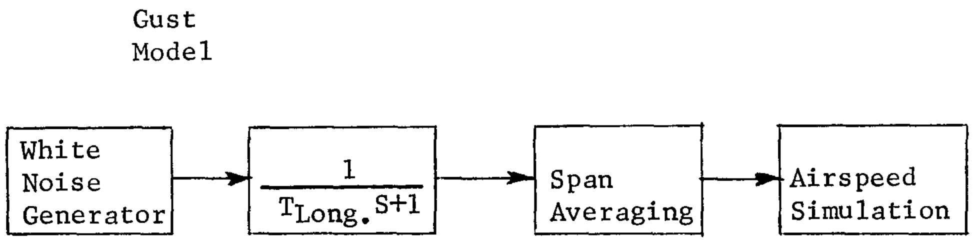
L = 600 feet
σ_v = .15 mean crosswind (knots) *

*


99.99
99.9
99
90
80
70
60
50
40
30
20
10
1.0
0.1
0.01
PROBABILITY OF EXCEEDING WIND SPEED - PERCENT
DOWNWIND
CROSSWIND
WIND SPEED - KNOTS
5
10
15
20

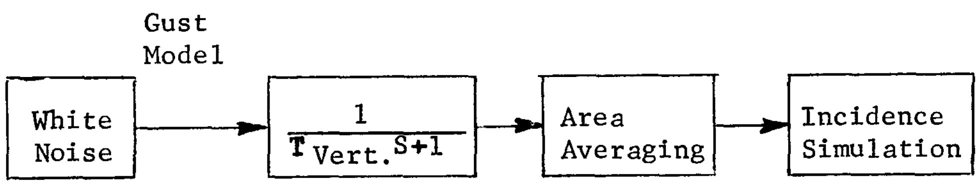
*

* Longitudinal Turbulence



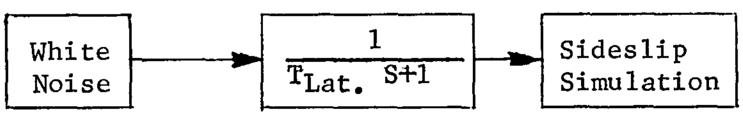
$T_{Long.}$ is $\frac{L}{V}$: where L is Longitudinal Scale Length = 600 ft
V = Approach Speed (ft/sec)

Vertical Turbulence



$T_{Vert.}$ is $\frac{L}{V}$: where L is Vertical Scale Length, approx 30 ft
V = Approach Speed (ft/sec)

Lateral Turbulence



$T_{Lat.}$ is $\frac{L}{V}$: where L is Lateral Scale Length = 600 ft
V = Approach Speed (ft/sec) *

T represents time constant "tau."
S represents the Laplace operator $\mathcal{L}$ where t denotes a real variable and S a complex variable:

$$\mathcal{L}[f(t)] = \int_0^\infty e^{-st} f(t)\,dt$$

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